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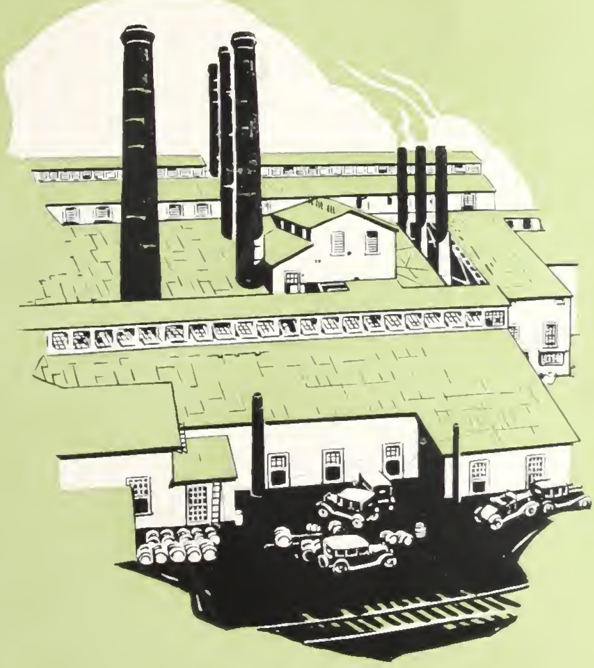
# WASTE HEAT RECOVERY

*at the*

## Hawkeye Portland Cement Co.



***with the***

**EDGE MOOR WASTE HEAT SYSTEM**

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## *at the*
# Hawkeye Portland Cement Co.

THE plant of the Hawkeye Portland Cement Company, located near Des Moines, Iowa, manufactures cement by the wet process, using about 36 per cent water in the slurry. There are six kilns in operation, each 8 feet in diameter and 125 feet long.

Prior to 1919, the company generated its steam for power with seven hand-fired boilers, rated at 360 h. p. each.

The expense involved in operating these boilers, which burned 125 tons of coal per day and required a large working force, was augmented by the fact that maintenance costs were unusually high. The nature of the feed water was such that scale formed very rapidly, and it was necessary to clean the boilers continuously, one at a time. Each boiler was cleaned on an average of once in four weeks. With one boiler always down for cleaning, the boiler room force found it difficult to meet steam requirements, and the plant production was accordingly curtailed.

These disadvantages finally made it imperative for the company to seek a different and less costly method of producing steam.

Application of stokers to the hand-fired boilers was first considered, but this would have required new settings, involving a heavy investment, and would have accomplished no reduction in fuel costs.

After making a careful study of conditions, Mr. Helmuth Krarup, superintendent of the plant, recommended to Mr. C. B. Condon, general manager, that a waste heat recovery system be installed. This proposal met with Mr. Condon's approval, in view of the successful utilization of waste heat in other wet-process cement plants, and he secured the permission of the directors of the company to proceed with the recommended change.

While it was realized that the installation of a waste heat system would require a greater investment than to equip the hand-fired boilers with stokers, the company officials felt that the greater returns from waste heat equipment, especially the saving in fuel, would more than offset the higher first cost.

An investigation of other wet-process plants showed that the only waste heat systems producing satisfactory returns had been installed by the Edge Moor Iron Company.

This company was accordingly requested to make a study of conditions at the Hawkeye plant, to be followed by a suggested plan for waste heat recovery.

## Edge Moor Waste Heat System Installed

The preliminary work, which was done under the direction of the late Mr. John E. Bell, of New York City, then consulting engineer for the Edge Moor Iron Company on all waste heat work, resulted in the installation of three Edge Moor Waste Heat Boilers, each containing 8047 square feet of heating surface.

Each of these boilers is of the Edge Moor special design for waste heat service and is twenty tubes high and eighteen tubes wide, with two drums. All tubes are 21 feet long. The baffling

Another view from rear of boilers, showing part of economizer.

provides for passage of the hot gases four times across the entire bank of tubes. The boilers are built for 200 lbs. pressure and are operated at 175 lbs.

Each is equipped with a Foster superheater specially designed for use in the Edge Moor Waste Heat Boiler, and proportioned to superheat the steam 100 degrees Fahrenheit.

Behind each boiler is an economizer of the horizontal tube type, built by the Green Fuel Economizer Company especially for the Edge Moor Waste Heat System, and having 2549 square feet of heating surface. The headers of the economizers form the side walls, and substantial insulated cover plates over these side walls and over the tops of the economizers complete the setting, which is practically air-tight.

Special fans—also built by the Green Fuel Economizer Company—are installed behind the economizers. They are designed to produce a maximum draft of 7 inches, and are driven by Terry steam turbines of 120 h. p.

Flue construction, end of main flue.

All of the above-described equipment was furnished by the Edge Moor Iron Company, together with the special castings for cleaning doors, dusting doors, dust spouts and dampers required in the boiler settings and in the flue and flue connections.

# The Edge Moor System of Flues

The three boilers are connected to the six kilns by a system of flues individual to, and forming an integral part of, the Edge Moor Waste Heat System. A short connecting flue joins each kiln to the main flue, which is perpendicular to the axes of the kilns, and into which the gases from all the kilns are discharged and thoroughly mixed before entering the boilers. Other short connecting flues carry the gases from the main flue into the boiler settings.

Flue construction, showing ample provisions for cleaning and, below, interior of main flue.

The main flue and the connecting flues are built of concrete and are lined with 9 inches of fire brick and $4\frac{1}{2}$ inches of Sil-O-Cel insulating brick to minimize heat losses through radiation.

By means of restricted openings in the connecting flues, the draft is equalized in the main flue and at the kiln housings. Uniformity in the operation of the kilns is thus secured, and the hot gases are evenly distributed among the three boilers.

The illustrations above show some of the details of the flue construction.

Draft gauges and recording pyrometers register the performance of the boilers and the kilns. The gases enter the boilers at a temperature of 1050-1100 degrees Fahrenheit and are

General view of plant of Hawkeye Portland

reduced to a temperature of 350 degrees on leaving the economizers.

Erection of the waste heat equipment was performed by the Hawkeye Portland Cement Company, under the direction of Edge Moor engineers. Incidental steel work, such as platforms, ladders, cover plates and breeching connections, was fabricated in the Hawkeye shops. The flues were designed by the engineering department of the Edge Moor Iron Company and built by the operating department of the cement company, who worked closely with the engineers in checking dimensions and assisting in the design work.

In order to prevent infiltration of excess air into the waste heat system, each kiln is equipped with an air seal where the kiln enters its housing. The air seal used was designed and built by the Edge Moor Iron Company, and patented by them. It consists of a floating steel ring held in place by guide plates and arranged to permit both endwise and lateral movement of the kiln. This design has proved highly effective in preventing excessive air infiltration, which, if permitted, would reduce the temperature of the gases entering the boilers and the amount of steam generated.

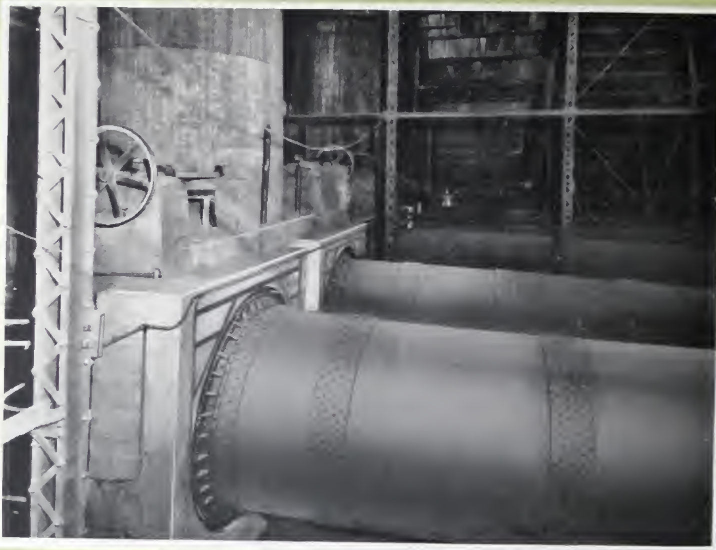
d Cement Company, Des Moines, Iowa

The illustrations on pages 8 and 9 show in detail the construction of the Edge Moor Air Seal.

# Description of Mill Equipment

The Hawkeye quarry, from which both the limestone and the shale used in the mill are secured, is located 30 miles from the mill. The raw materials are hauled to the mill by railroad, and on arrival are dumped into a No. 18 gyratory crusher, thence passing to No. 6 Jumbo Williams swing hammers before going to the grinding machines. Then four No. 85 Smidth Kominuters and three No. 18 Smidth Tube Mills prepare the material for burning in the kilns.

Clinker passes from the kilns into rotary coolers, and is then stored for later grinding, or passed directly through four No. 85 Smidth Kominuters and three No. 20 Smidth Tube Mills. The finished cement is elevated into 80-foot silos by a Fuller-Kinyon pump, which aerates the cement and forces it through a 5-inch pipe line. A belt conveyor then carries the cement to the old warehouse.



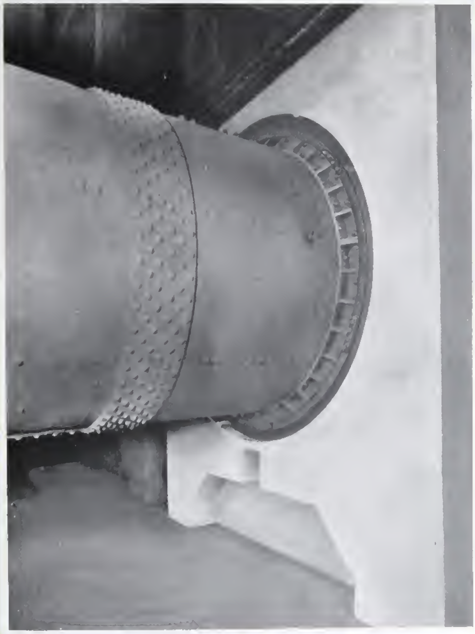
View in Kiln Room, showing kilns equipped with Edge Moor Air Seals.

A very complete laboratory is maintained and every batch of cement is subjected to exacting tests, for it is a fixed policy of the company to keep the quality of their product well above the standard requirements for portland cement.

The power plant—in addition to the Edge Moor Waste Heat System—consists of one 1000 k. w. and one 500 k. w. Allis-Chalmers Corliss engines, both exhausting into a 1000 k. w. low-pressure DeLaval turbine. There is also a 600 k. w. high-pressure DeLaval turbine. No change in the power plant equipment was made when the waste heat system was installed, and the fact that the company already had adequate prime mover equipment resulted in lessening the expense of changing from hand-fired boilers to waste heat utilization.

The installation of waste heat recovery equipment by this company was an important part of an extensive program of improvements designed to raise the quality and uniformity of the product and to decrease operating expense. Other new equipment installed at the same time included grinding machinery, burning apparatus and fans for the burners.

Realizing that the feed water which they were using was certain to cause troublesome scale formation in the boilers,

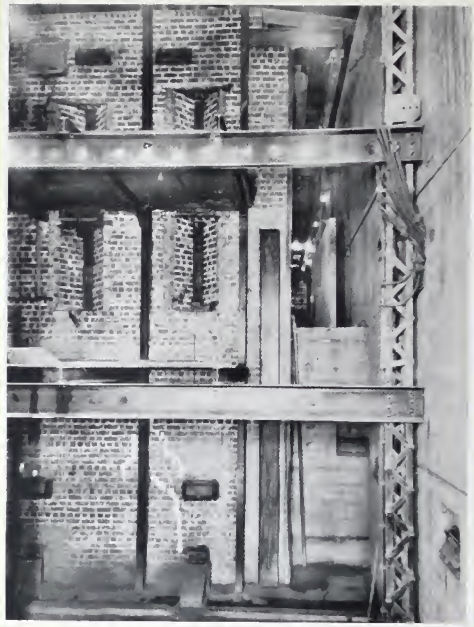


Here the construction of the Edge Moor Air Seal is shown in greater detail.

the company also installed a water-treating plant and a Reiter continuous boiler cleaning system. After these were put into operation, a test run was made in the boiler plant, and the boilers were run for one year without shutting them down for cleaning. At the end of this period, the boilers were found to be reasonably clean and free from scale, but some dirt and solid matter had been carried over to the engines. This trouble has now been overcome by Tracy steam purifiers, so that the cleaning expense is very low.

As a result of the installation of waste heat equipment and other improvements, the Hawkeye Portland Cement Company has been able to increase the capacity of the plant from 3600 barrels per day to 4500 barrels per day, with the same kilns. This increase of 25 per cent was effected without increasing the amount of coal burned per barrel of clinker produced.

Part of the increased production is credited directly to the waste heat system, as the operators of the plant realize that the improved control of the draft on the kilns made possible



Side of one boiler, showing clean-out doors.

by the waste heat system enables more uniform operation of the kilns and consequently greater capacity. No effort has been made, however, to determine exactly how much of the increase in capacity is due to the waste heat system alone. It would be virtually impossible to secure such figures, since the new burners were installed and other improvements made simultaneously with the erection of the waste heat system, and all of the new equipment was put into service at the same time.

## Savings Effected by Waste Heat Recovery

When the first waste heat recovery systems were installed in connection with cement plants and the practice was still in a more or less experimental stage, most operators wanted to know exactly what returns could be obtained from the

General view over tops of boilers and main flue.

waste heat plant, and careful tests were run to determine this. The object of many of these tests was to ascertain the maximum capacity of the waste heat system, even though the attainment of this maximum might mean a slight sacrifice in the efficiency of the plant as a whole. Such sacrifices in over-all efficiency were usually more than offset by the savings effected by the waste heat system.

When the Hawkeye Company's waste heat plant was ready for operation, the results obtainable from similar installations were already known, and the company officials realized that sufficient steam for all requirements could be recovered from the waste gases without experimenting along these lines. Accordingly their attention was devoted to operating the waste heat system as a unit of the cement mill, subordinating its capacity to the over-all efficiency of the entire mill. This, of course, is the true measure of the value of waste heat equipment, since it shows whether or not it will be a profitable investment under normal operation.

Aside from assisting materially to increase production, the Hawkeye waste heat system is credited with a large saving in the cost of power. When the kilns and grinding machinery are

properly balanced, the waste heat boilers furnish all the steam required in the operation of the plant. They have carried the entire load for several weeks at a time without any assistance from the direct-fired boilers in the old power plant. However, as it is not always possible to balance the load exactly, there are times when the waste heat boilers furnish more steam than is needed, and other times when a direct-fired boiler must be put into service to help carry the load.

The saving in coal burned for power purposes has shown a very substantial return on the investment for waste heat equipment, and there has been a further credit to the waste heat system of about $65.00 per day, representing the saving in labor costs in the old power plant. The company has found that with the waste heat system power costs have been cut down to very close to one-half cent per kilowatt hour, and during some months the cost has been even below this figure. Average power production is 72,000 kilowatt hours per 24-hour day.

In a paper on "The Economic Limit and Operating Flexibility of Waste Heat Boiler Installations," read before the annual meeting of the Portland Cement Association in 1924, Mr. Helmuth Krarup, superintendent of the Hawkeye Company, stated that he could not conceive of a condition which would prevent any cement kiln in operation today from yielding sufficient steam to operate a plant if it were properly connected to a waste heat boiler installation. Mr. Krarup's remarks in this connection are here quoted:

"The question of where and how to take stack temperature readings, and what temperature and volume of gases were needed to justify an installation of waste heat boilers, has been subject for much discussion in past meetings of the Conservation Committee, and perhaps some have reached the conclusion that their conditions did not justify a waste heat boiler installation.

"I cannot conceive of a condition which would prevent any kiln in operation today, regardless of size or length, dry or wet process, to be connected to a waste heat boiler installation and fail to yield sufficient steam to operate the plant, if the installation was properly made."

In the same paper Mr. Krarup also made these statements:

"The Hawkeye power plant is fifteen years old. . . . A modern power plant would produce about 50 per cent more power for a smaller total cost. . . .

"The fear has been expressed that a waste heat plant might be a handicap in independent and proper kiln operation, but such is not the case. If anything, it is an asset to the kilns. By furnishing better draft regulation, waste heat boilers tend toward more uniform operation of the kilns."

While the Hawkeye installation is not a demonstration of abnormal capacities or unheard-of economies, it provides further convincing proof that the Edge Moor Waste Heat System can be installed in a wet-process cement mill and produce excellent results and a highly profitable return on the investment.

Much of the success of this installation is undoubtedly due to the officials of the Hawkeye Portland Cement Company who assisted in the design, installation and operation of the plant, including Mr. C. B. Condon, general manager; Mr. Helmuth Krarup, superintendent; Mr. Bennett, assistant superintendent; Mr. J. V. Mandia, chief chemist; and Mr. E. H. Hawley, chief power plant engineer.

An engineering staff trained in the solution of waste heat recovery problems is maintained by the Edge Moor Iron Company. Their services are available to those interested in the utilization of waste heat, and correspondence is invited. Address the Edge Moor Iron Company, Edge Moor, Delaware.

EDGE MOOR
Water Tube BOILERS
FOR INCREASED FUEL ECONOMY

*Prepared by McLain-Simpers Organization, Philadelphia—New York*